Automatic analysis of biological images

The Flemish biotechnology industry is a fast growing industry, as can be seen in events like this. However, the number of bio-engineered products that reach the market is only a small part of the wide range of ideas tested in R&D labs. Typically, such tests are designed to measure the effect of a given treatment in samples. Observable effects include growth, motion and behavioural changes. The aim of image analysis is to obtain a quantitative description of such variations. Thus, a specialist needs to outline the biological objects in images or video sequences before any measurement can be taken. This is done manually, which is a tedious, error-prone and time consuming task. Currently, an increasing number of tests use automatic image acquisition systems. They provide new possibilities for R&D, however, manual process is still the main bottleneck in the chain.

In order to assist scientists with tests that demand quantitative image analysis, we have developed several computer vision techniques (CVT's) to automate the outlining of objects in images or videos. Our work has been done for samples at macroscopic and microscopic scales. Image data sets employed in our experiments include in-vivo and in-vitro samples of animals and plants.

At macroscopic level, images correspond to time lapse sequences of plants. Which were captured with a system equipped with a thermal, a fluorescence and a CCD camera [1]. Therefore, information about temperature, chlorophyll, movement, growth, etc. could all be extracted using these sequences. Due to the characteristics of the images, we adapted existing CVT's to cope with the following problems:

- Low resolution and contrast of the images
- Large movement of leaves between consecutive frames
- High noise levels in the images

At microscopic level, we focused our efforts on images of cells and nematodes. Cell counting and size distribution are the most common measurements extracted from these images. Thus, identification of biological structures was the aim of our work. We developed specific solutions for each type of image as the features used for recognition, depend on the microscopic technique applied and the properties of the specimen. CVT's have been developed for the following applications:

- Counting specific type of cells using confocal microscopy images
- Extracting cellular walls of leaves in phase contrast (DIC) microscopy images
- Extracting statistics from nematode populations in bright field microscopy images

A wide range of CVT's have been developed for the automatic analysis of biological images in numerous applications. Our experiments show that: 1) under controlled conditions the time required for quantitative analysis can be reduced by using CVT's. 2) To be effective, image processing routines should consider the characteristic of the specimen and the imaging technique used.

[1] These where captured and analyzed by Dr. L. Chaerle, Unit Plant Hormone Signaling & Bio-imaging, Department of Physiology, Ghent University.

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